

University of Stuttgart
4th Physics Institute



UNIVERSITÄT
DUISBURG
ESSEN

Offen im Denken

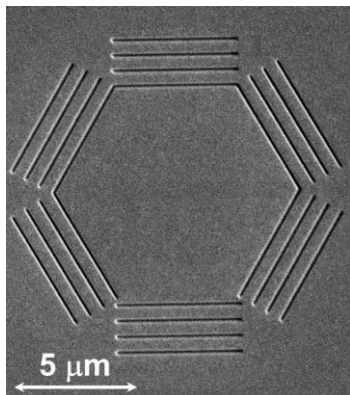


Topological Plasmonics on Single Crystalline Gold Platelets

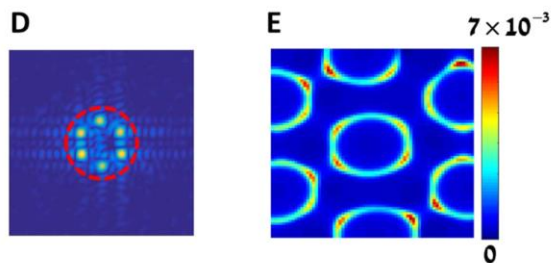
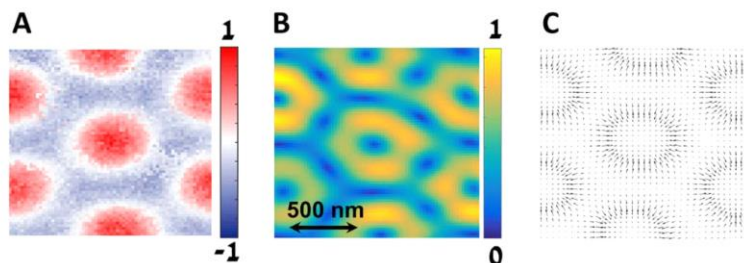
Bettina Frank, Pascal Dreher, Alexander Neuhaus, Philip Kahl,
Timothy J. Davis, Frank-J. Meyer zu Heringdorf, and Harald Giessen

SPICE Workshop on Spin textures: Magnetism meets Plasmonics

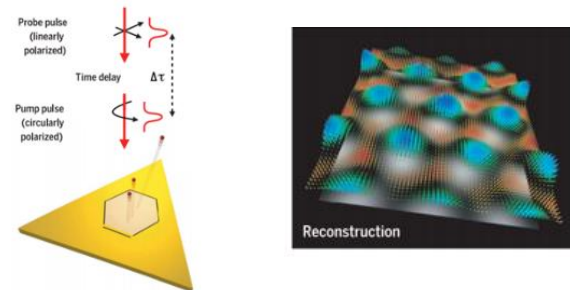
24.07.2024



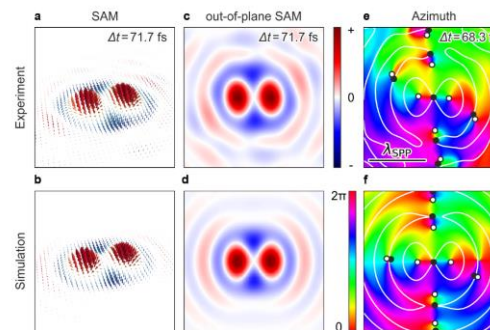
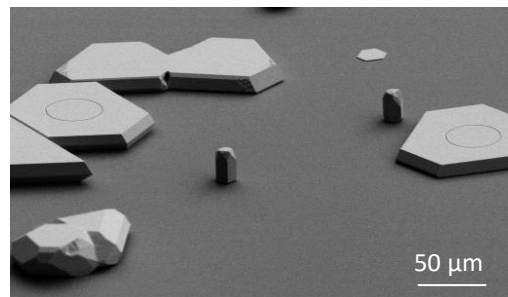
Plasmonic skyrmions



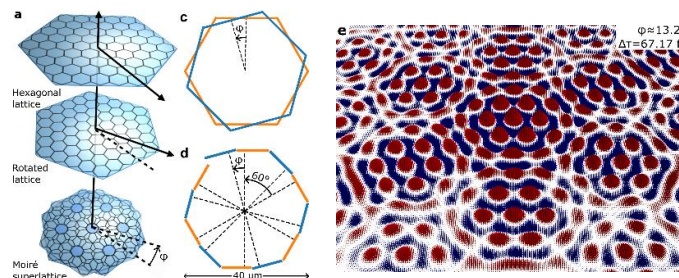
S. Tseses et al., Science **361**, 993-996 (2018)



T. J. Davis et al., Science **368**, eaba6415 (2020)



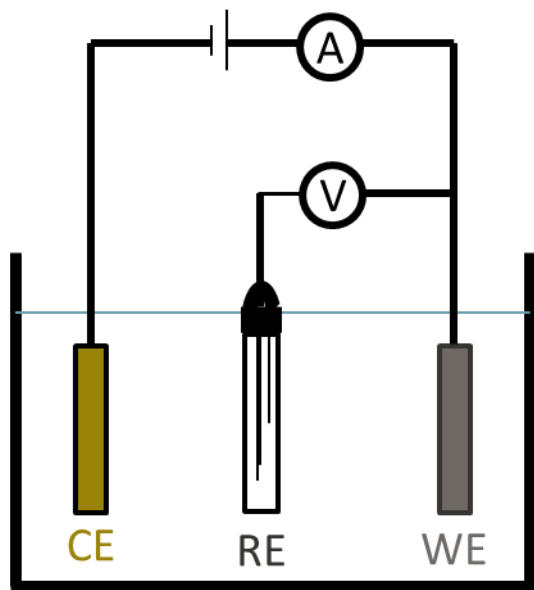
P. Dreher et al., submitted (2024)



J. Schwab et al., submitted (2024)

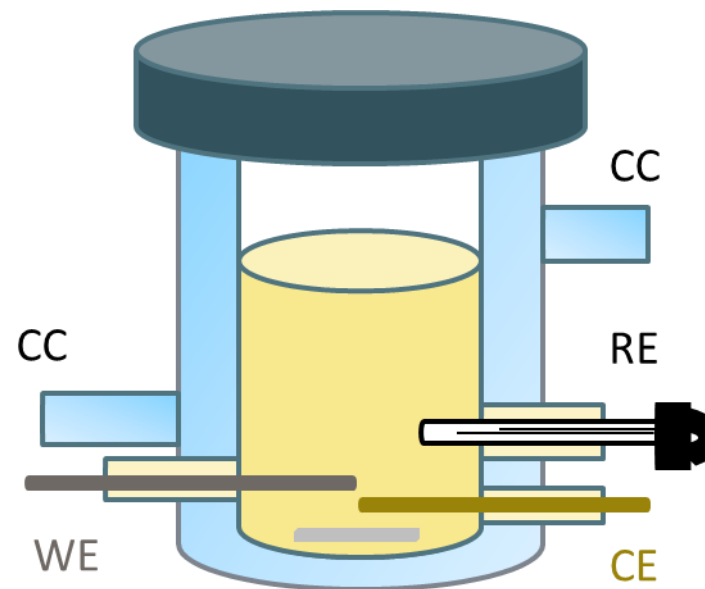


Three-electrode setup

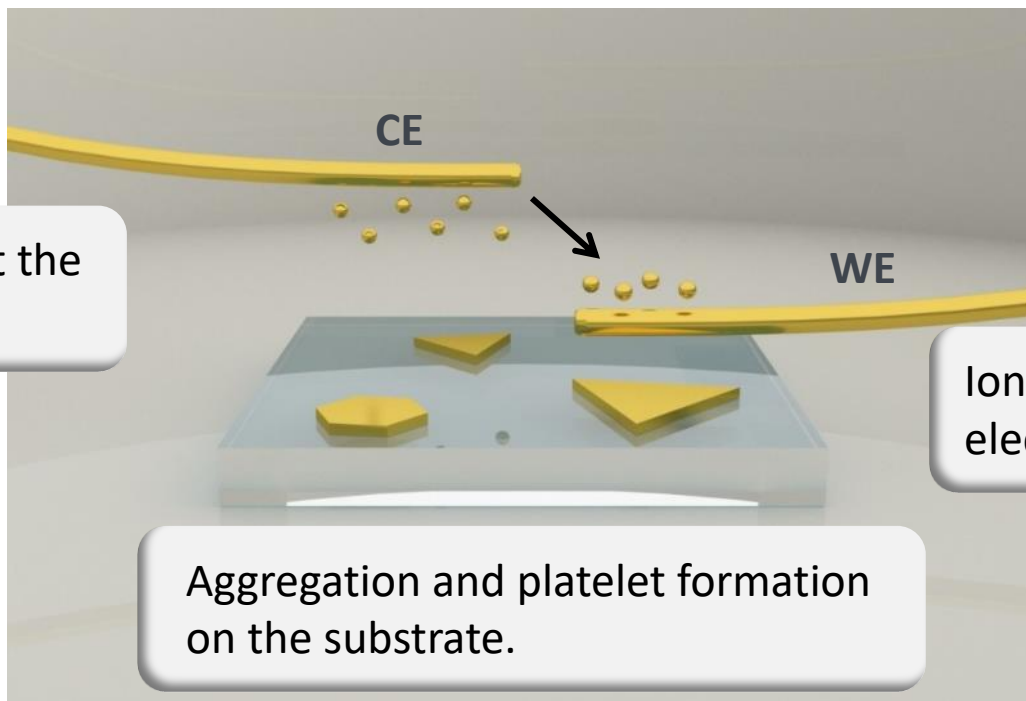


Potentiostat regulates the potential between WE and RE by controlling the current between CE and WE.

Electrochemical cell



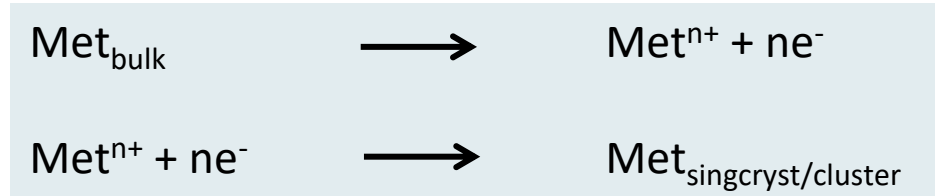
- CE: Counter electrode
- WE: Working electrode
- RE: Reference electrode
- CC: Chiller connections



Gold dissolution at the counter electrode.

Ion reduction at the working electrode and in the electrolyte.

Aggregation and platelet formation on the substrate.

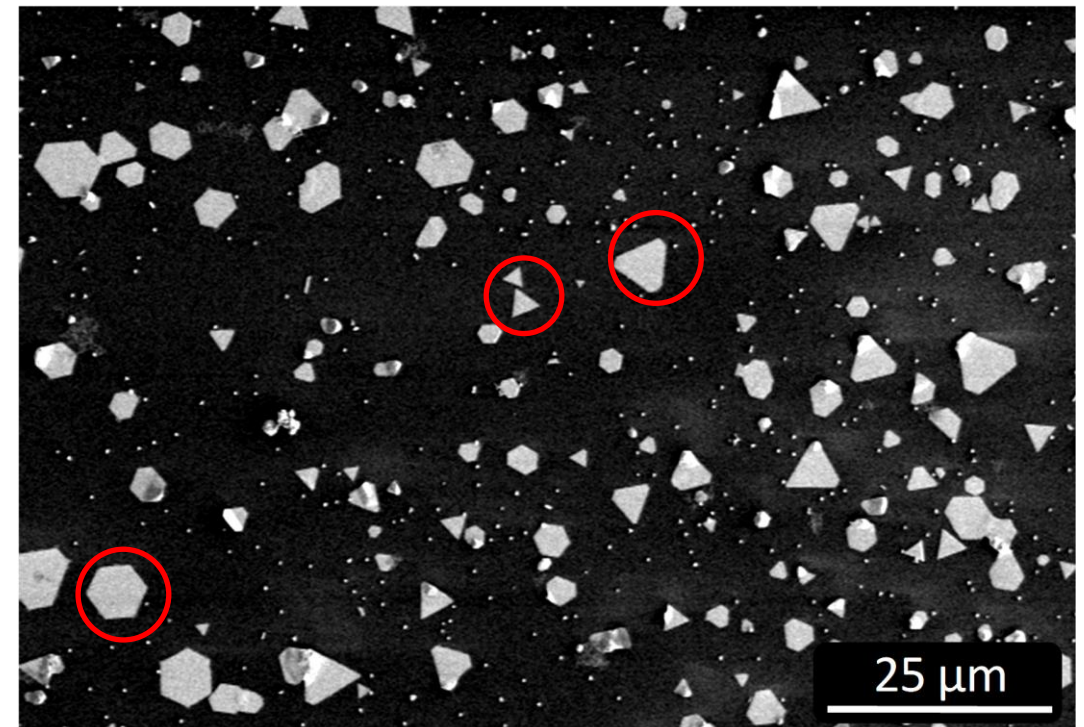
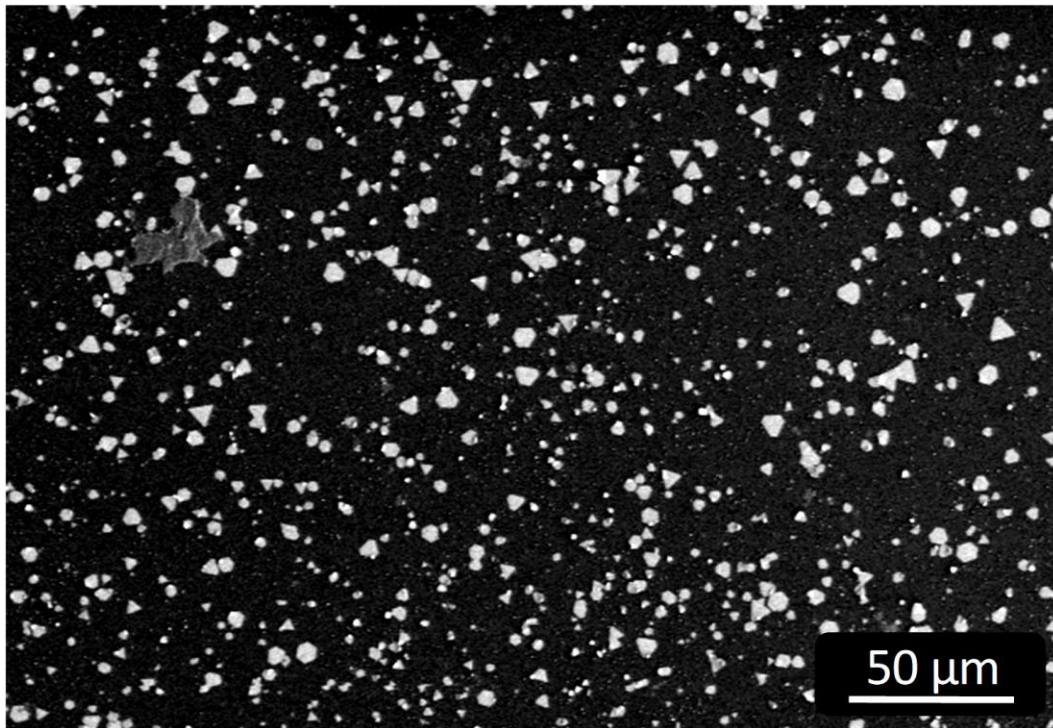


M. T. Reetz and W. Helbig, J. Am. Chem Soc. **116**, 7401-7402 (1994)



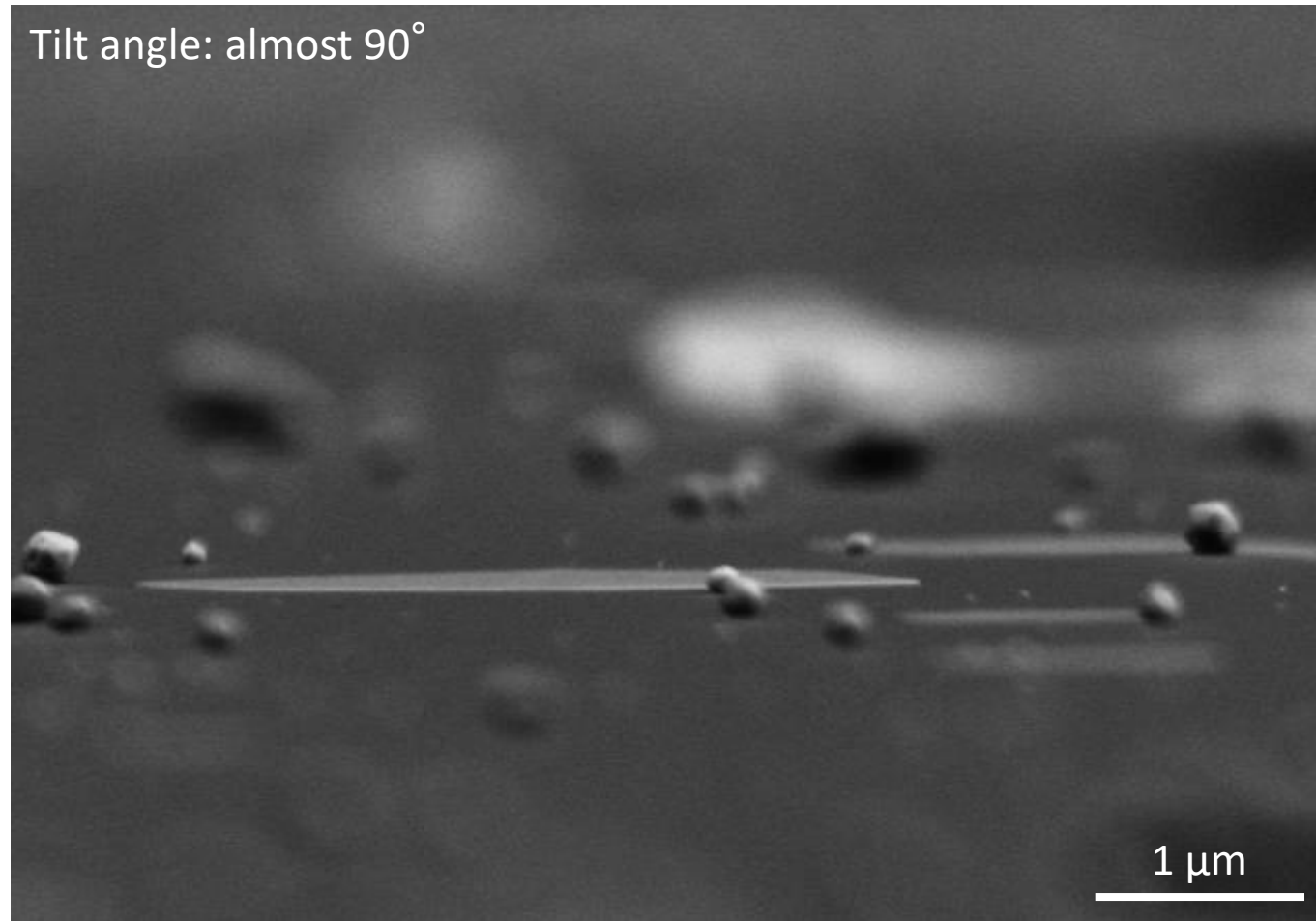


SEM overview





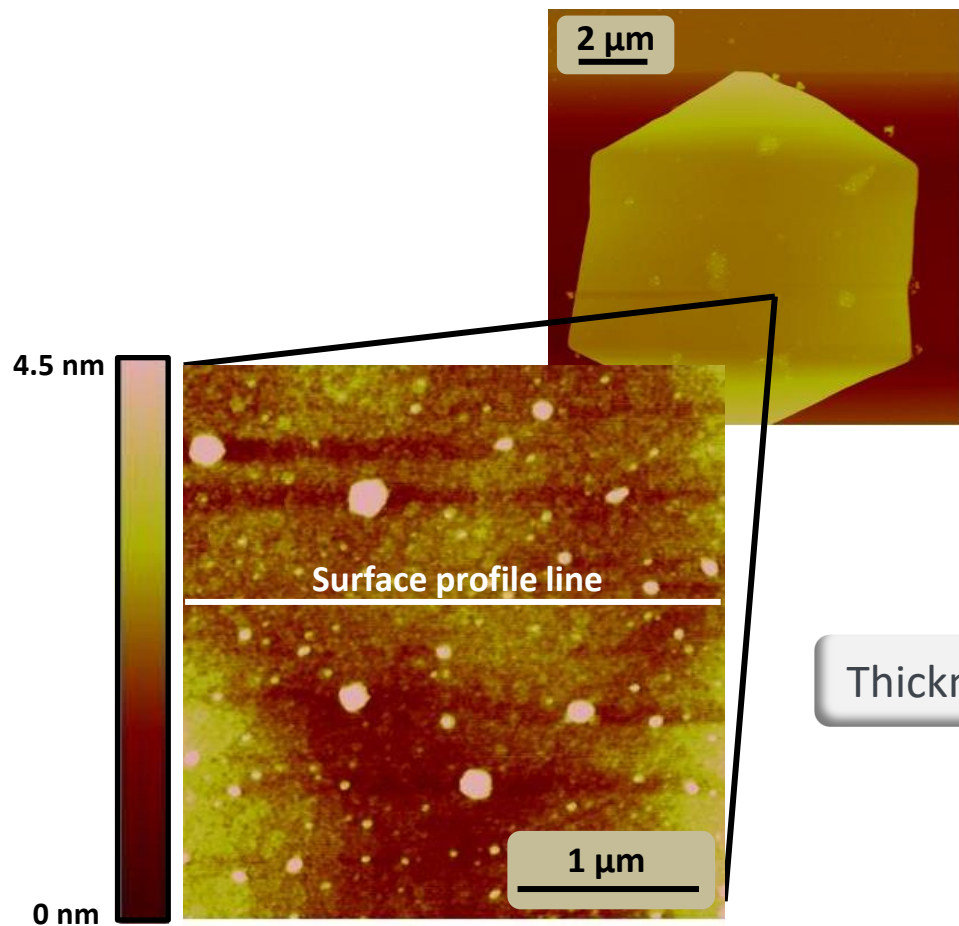
SEM – surface flatness



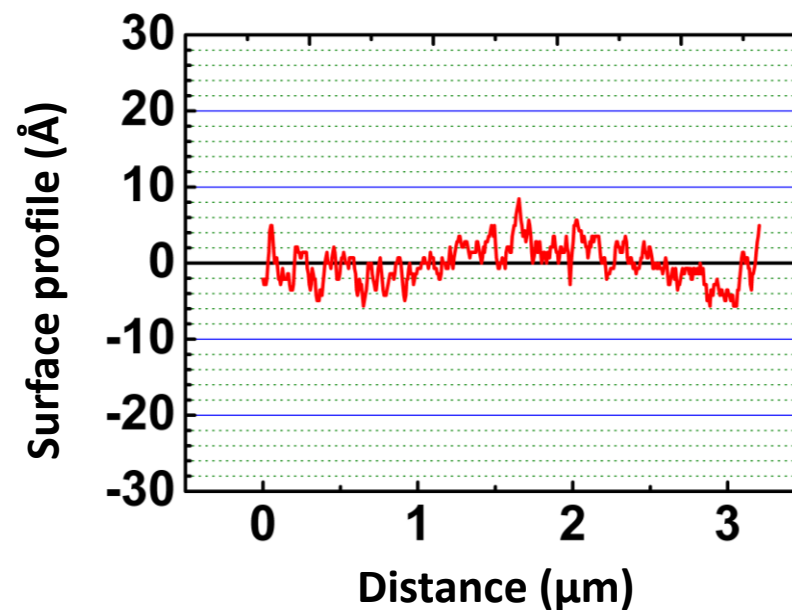


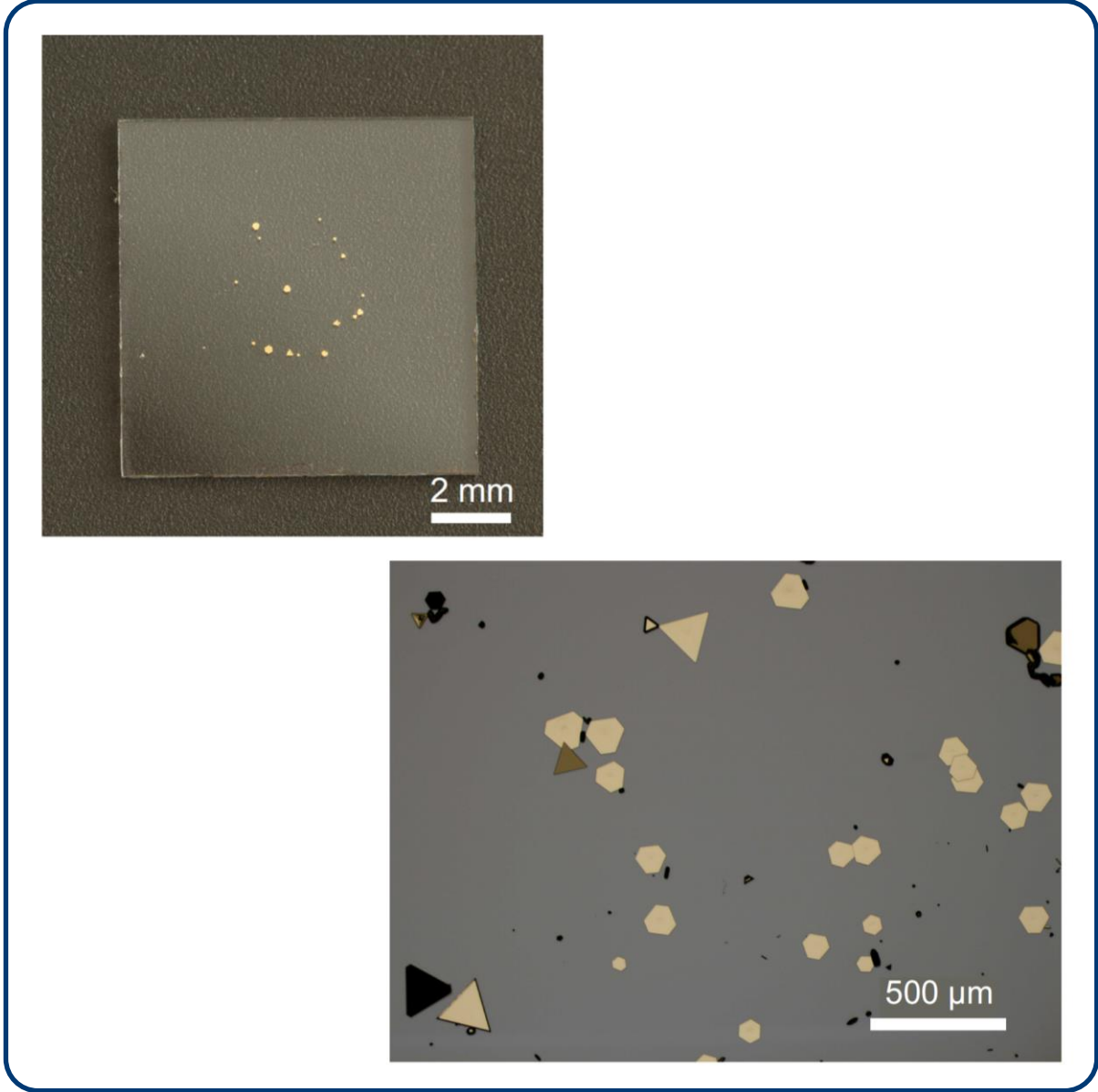
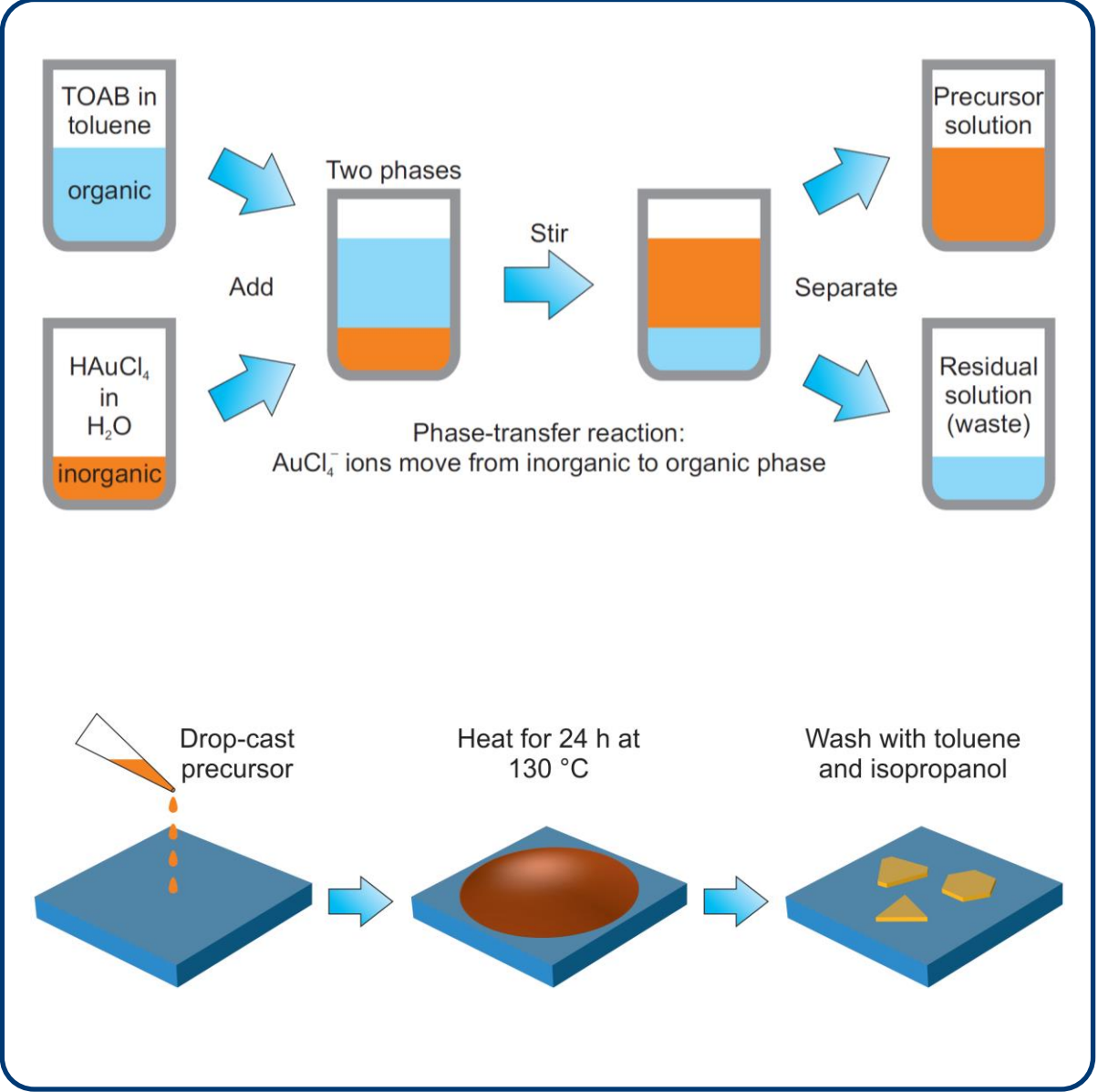
AFM – surface flatness

The surface is atomically flat - below 10 Ångströms.



Thickness: 20 – 30 nm

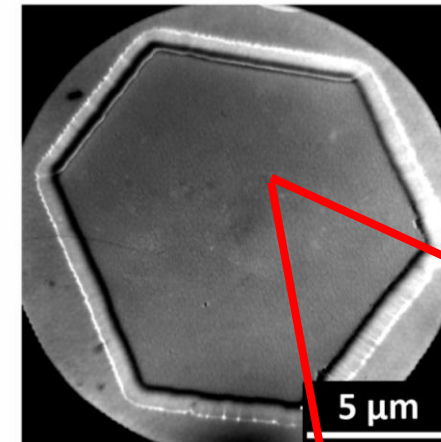
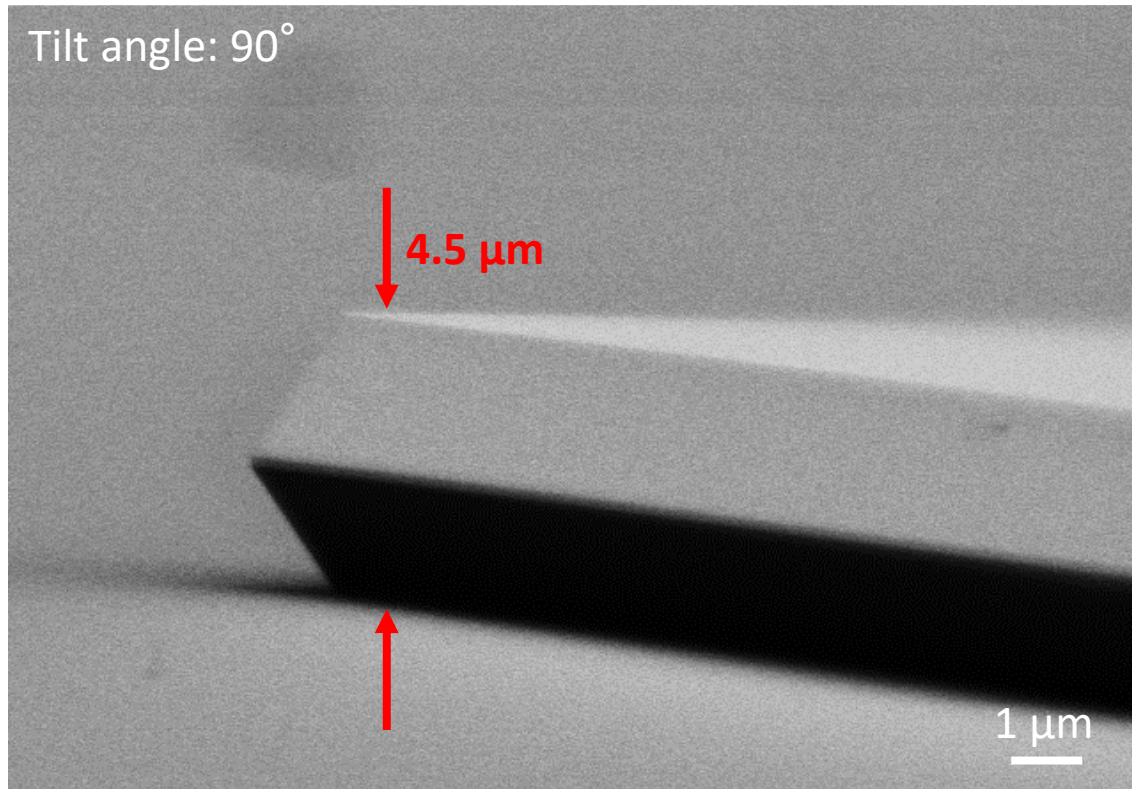






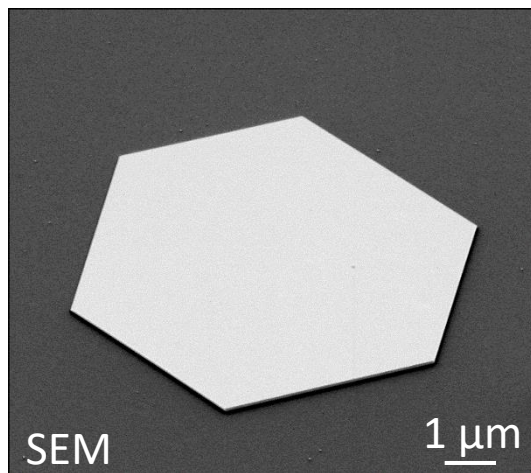
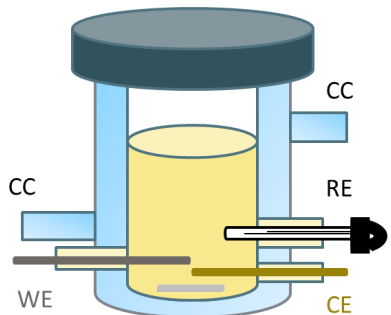
Results

Low energy electron microscopy (LEEM)



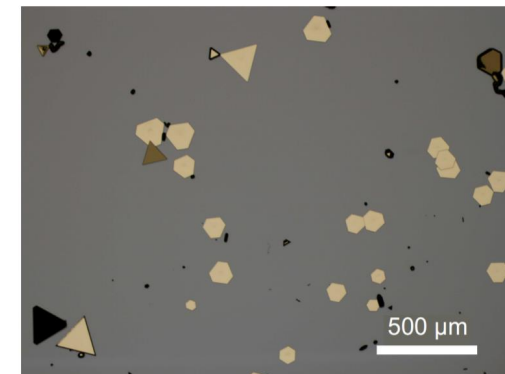
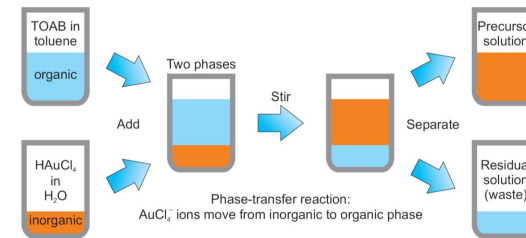


Electrochemical synthesis



- Lateral size: about 10 μm
- Thickness: 20 – 30 nm
- Surface quality: atomically flat

Phase transfer reaction



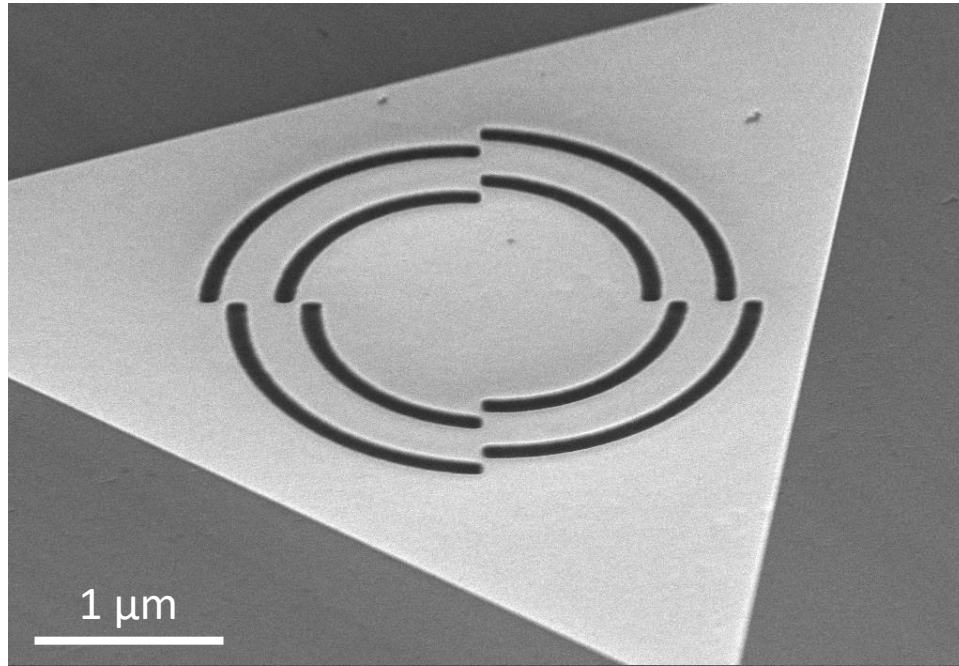
- Lateral size: more than 100 μm
- Thickness: several micrometers
- Surface quality: atomic steps



Two-ion column: 1) Au^+ , Au^{++}
2) Si^{++}



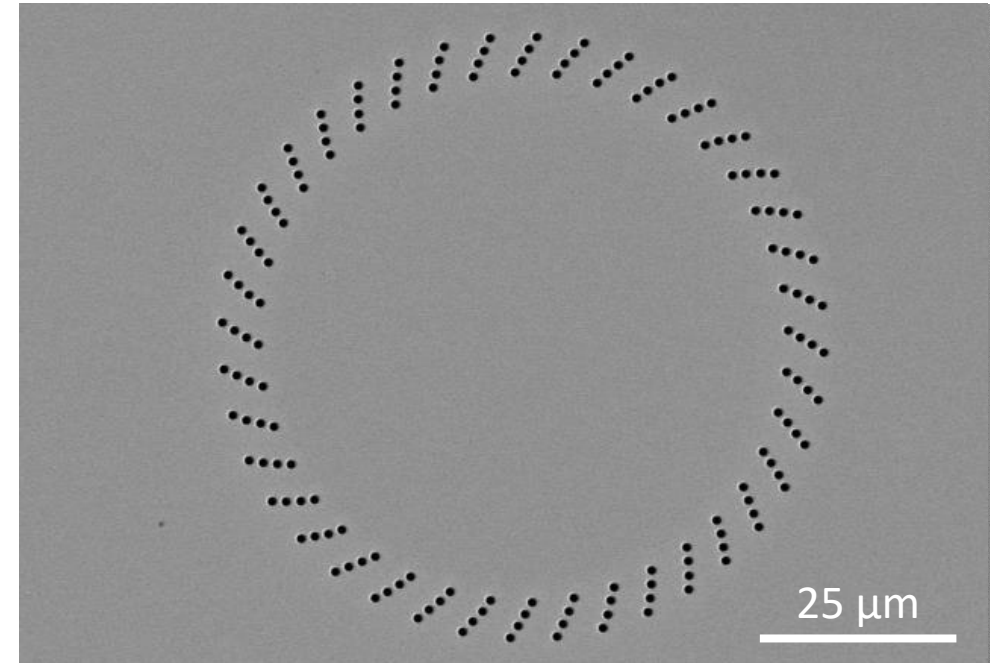
Electrochemical synthesis



B. Frank et al., *Science Advances* **3**, e1700721 (2017)

G. Spektor et al., *Science* **355**, 1187 (2017)

Phase transfer reaction

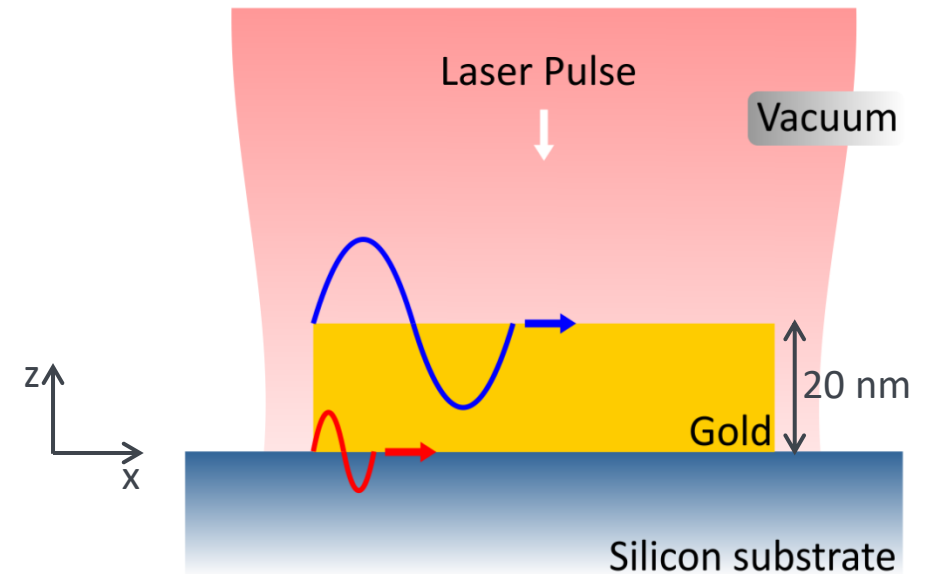
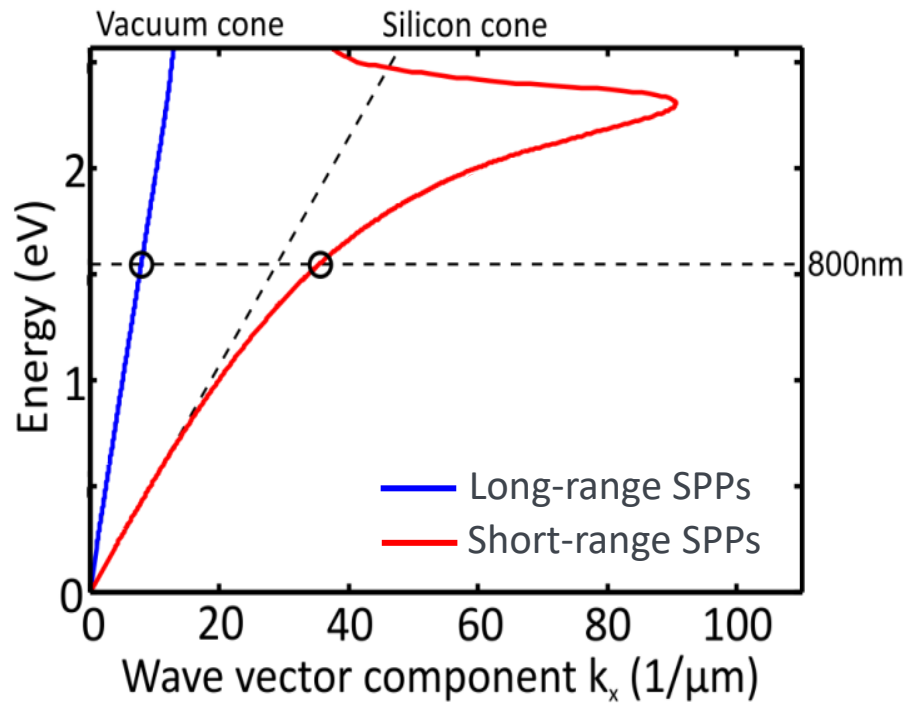


T. J. Davis et al., *Science* **368**, eaba6415 (2020)

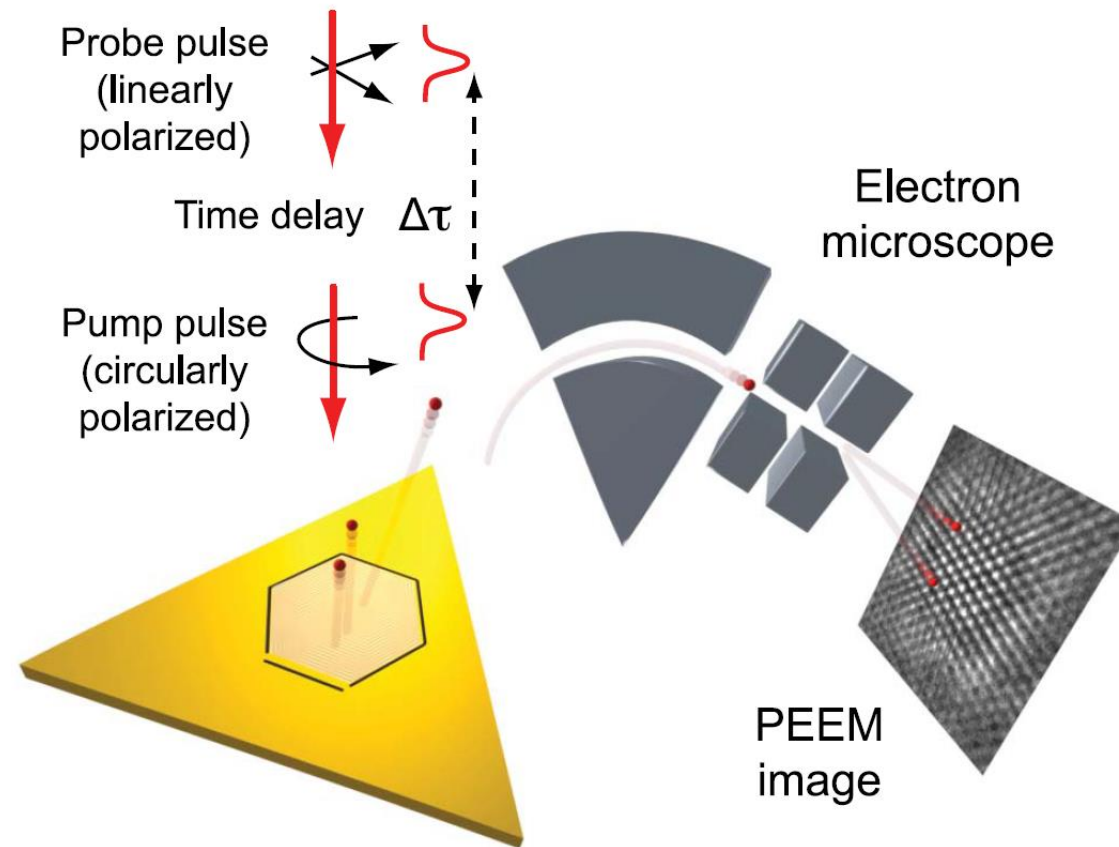
Z. Jin et al., *eLight* **1**, 5 (2021)



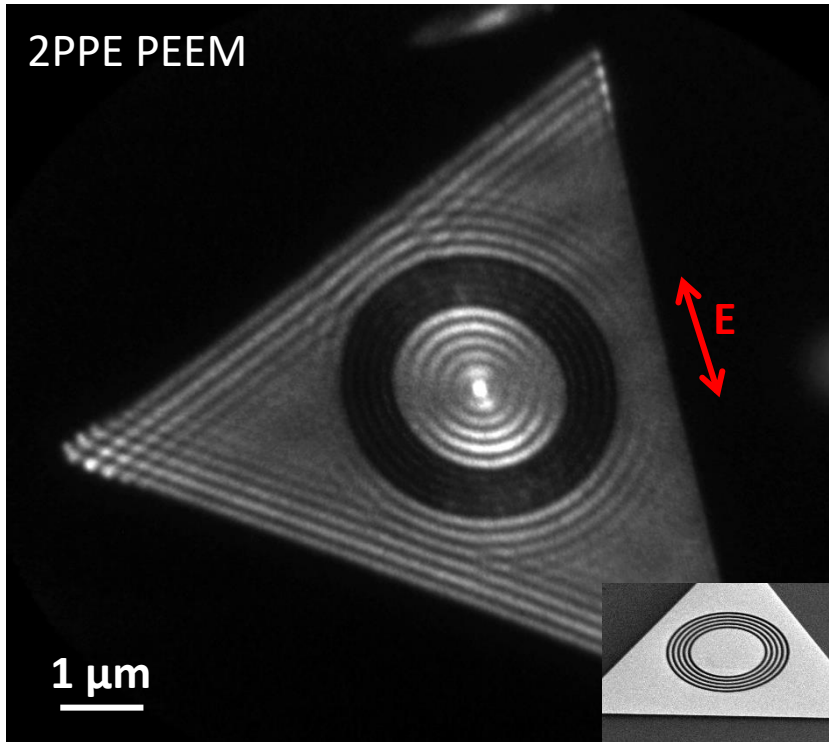
Vacuum	ϵ_1
Gold	ϵ_2
Silicon	ϵ_3



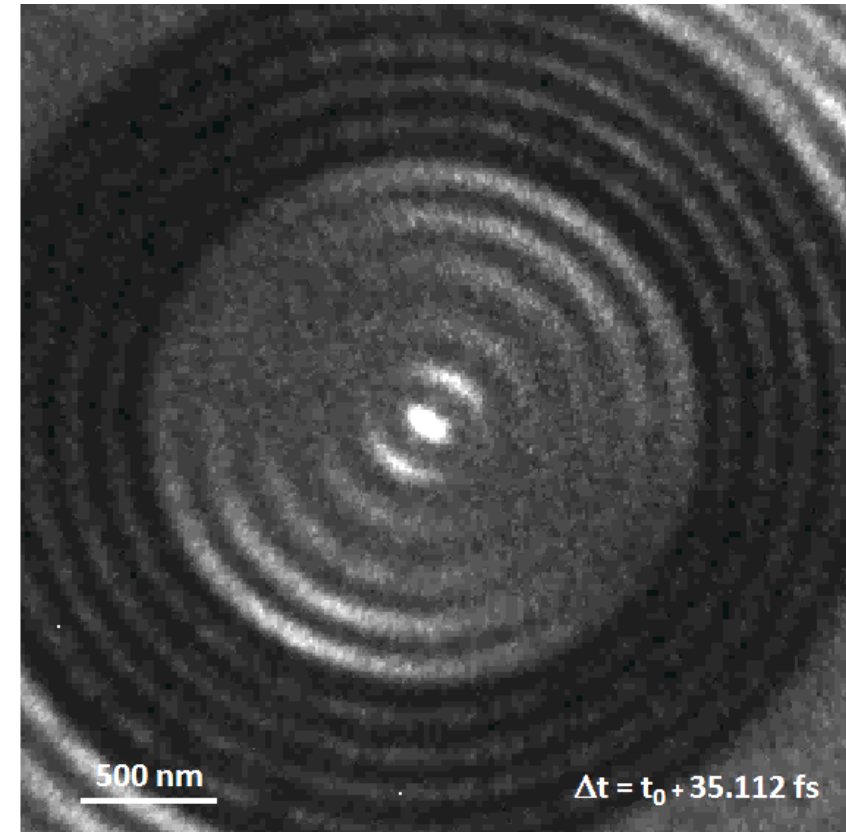
B. Frank et al., Science Advances **3**, e1700721 (2017)



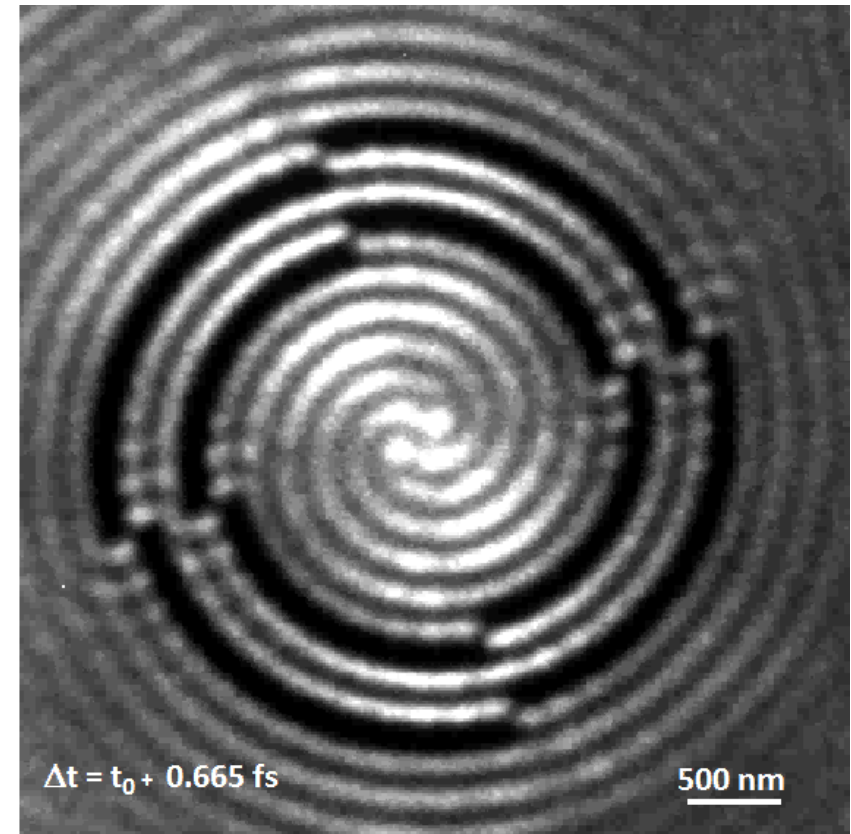
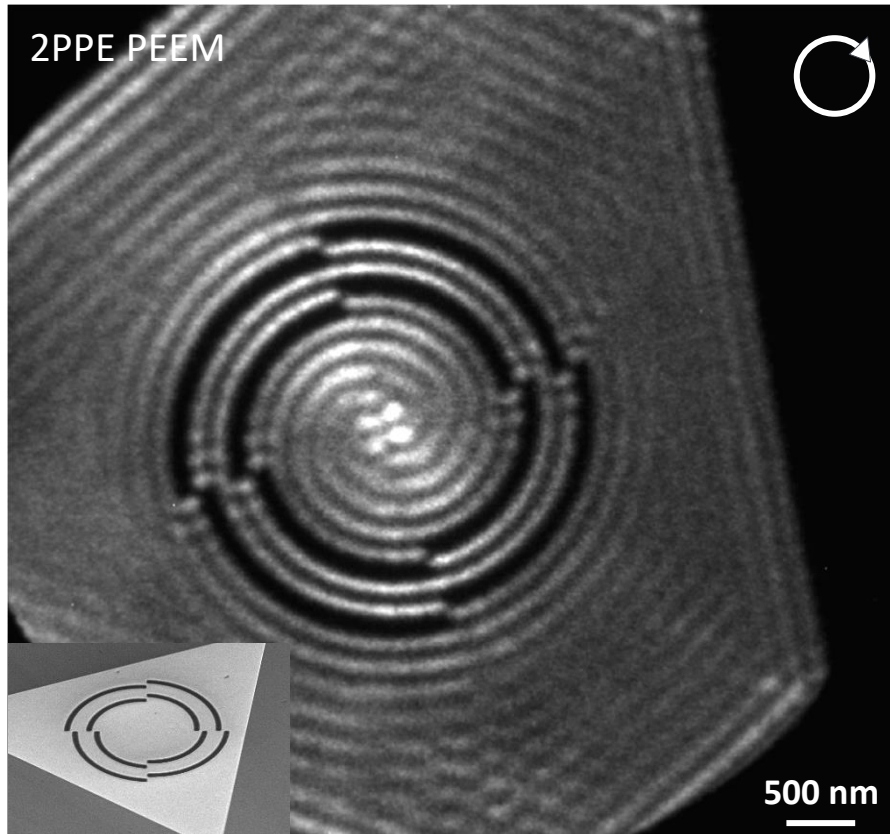
T. J. Davis et al., Science **368**, eaba6415 (2020)



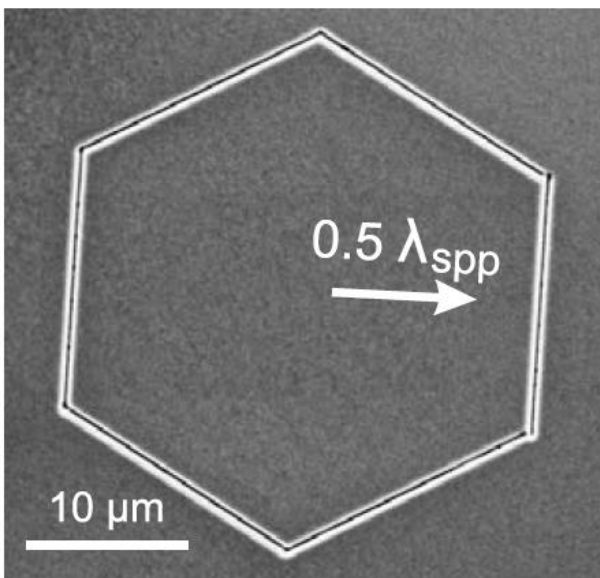
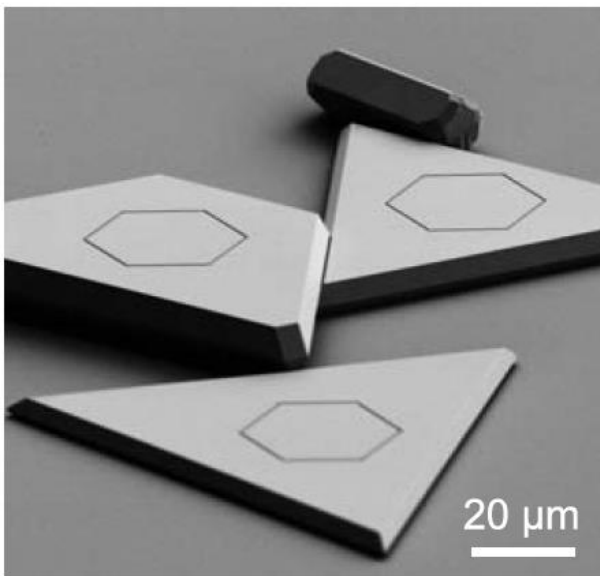
$$\lambda_{\text{SR-SPP}} = 170 \text{ nm}$$



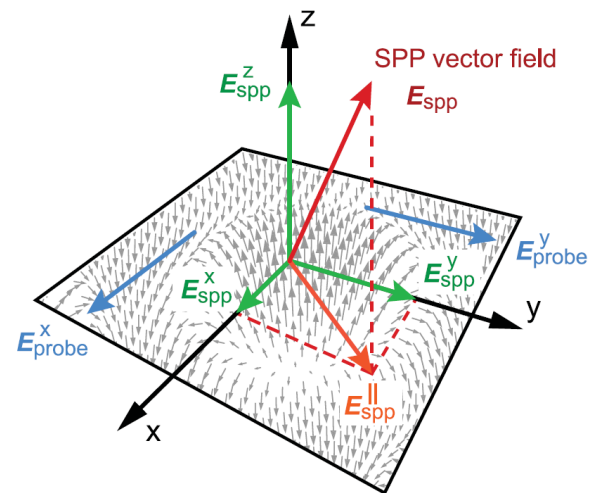
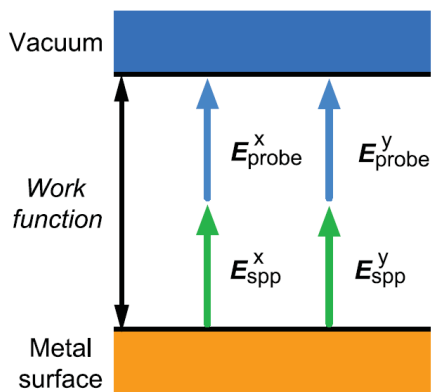
B. Frank et al., Science Advances **3**, e1700721 (2017)



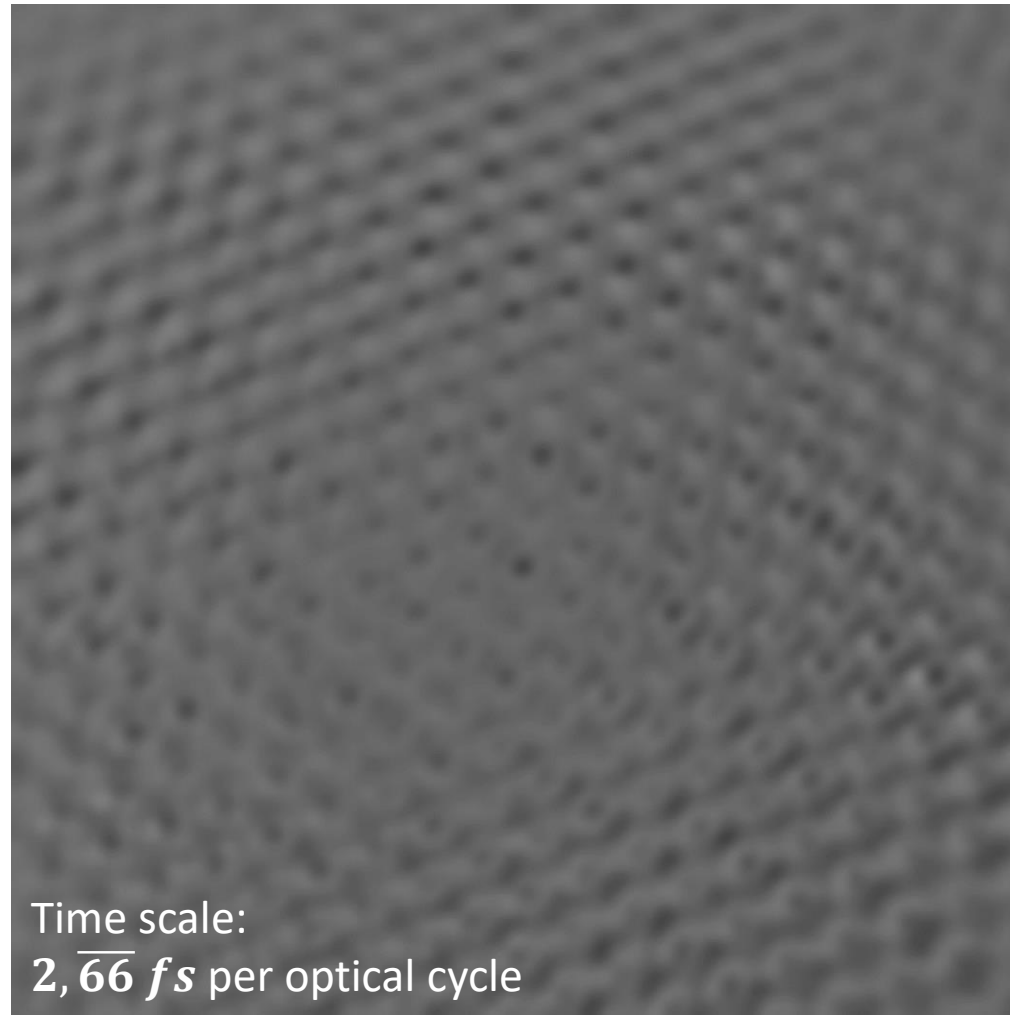
G. Spektor et al., Science **355**, 1187 (2017)



- SPP excitation with circularly polarized laser pulses.
- SPP probe with linearly polarized laser pulses.

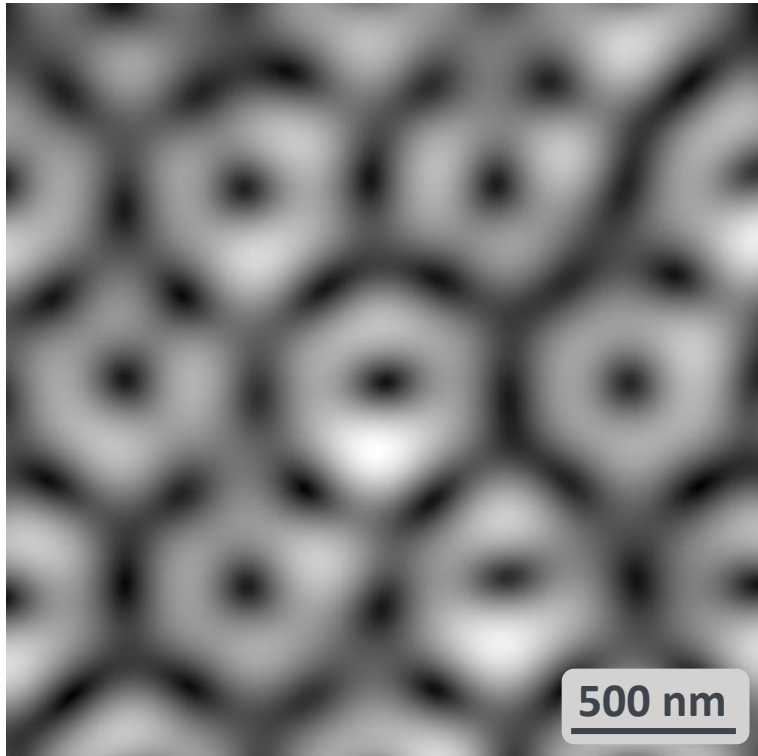


T. J. Davis et al., Science **368**, eaba6415 (2020)

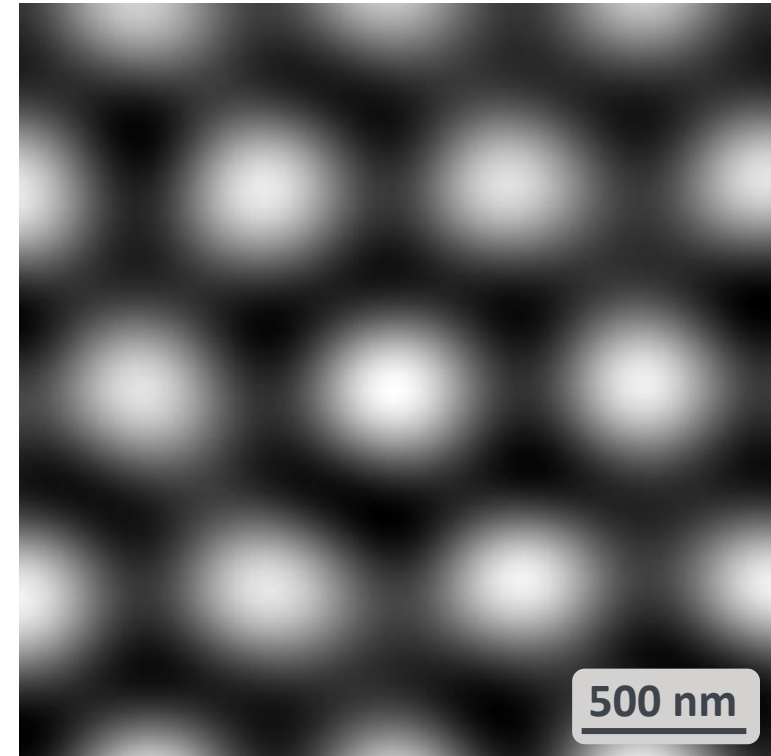




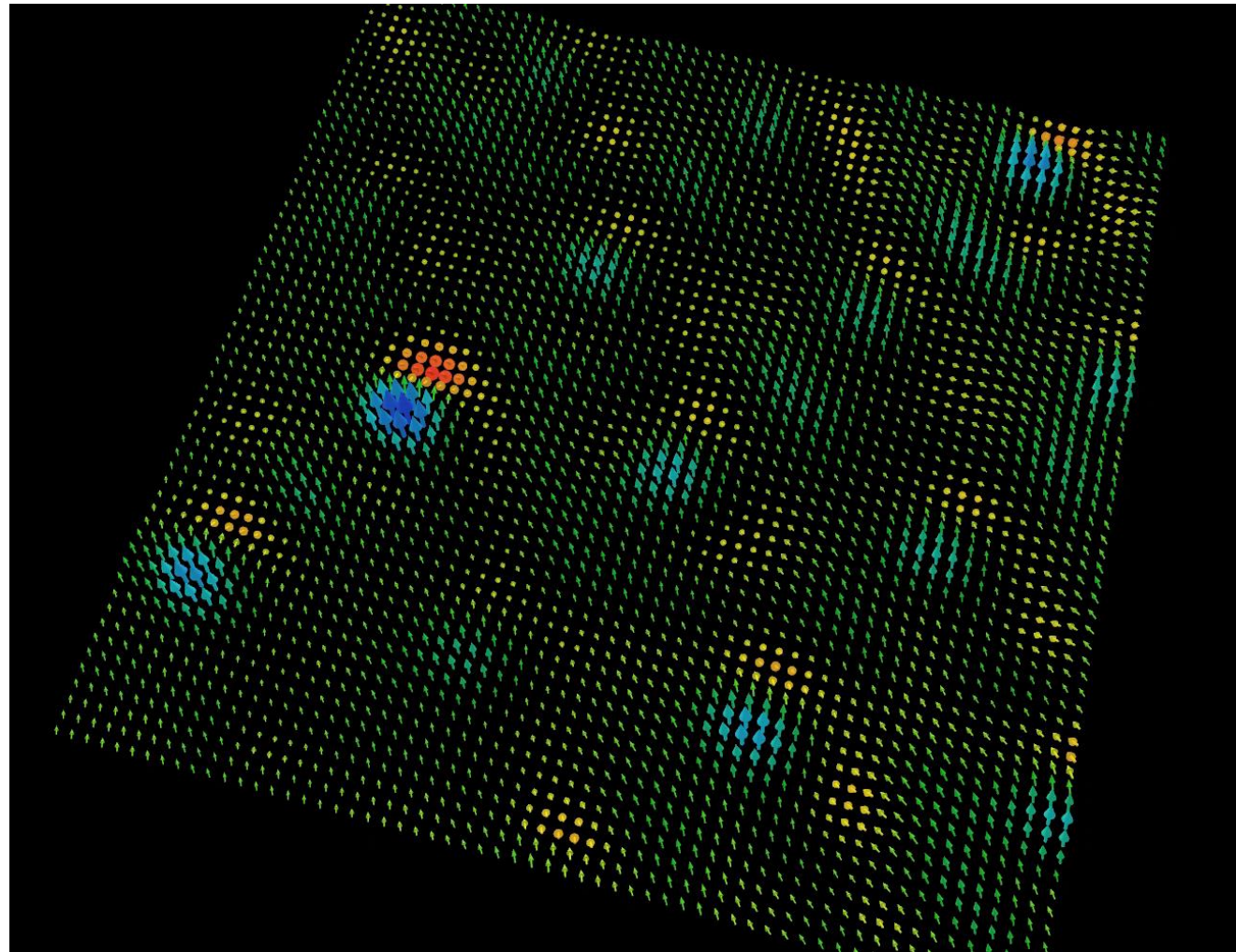
E-field in the xy-plane



E-field in z-direction

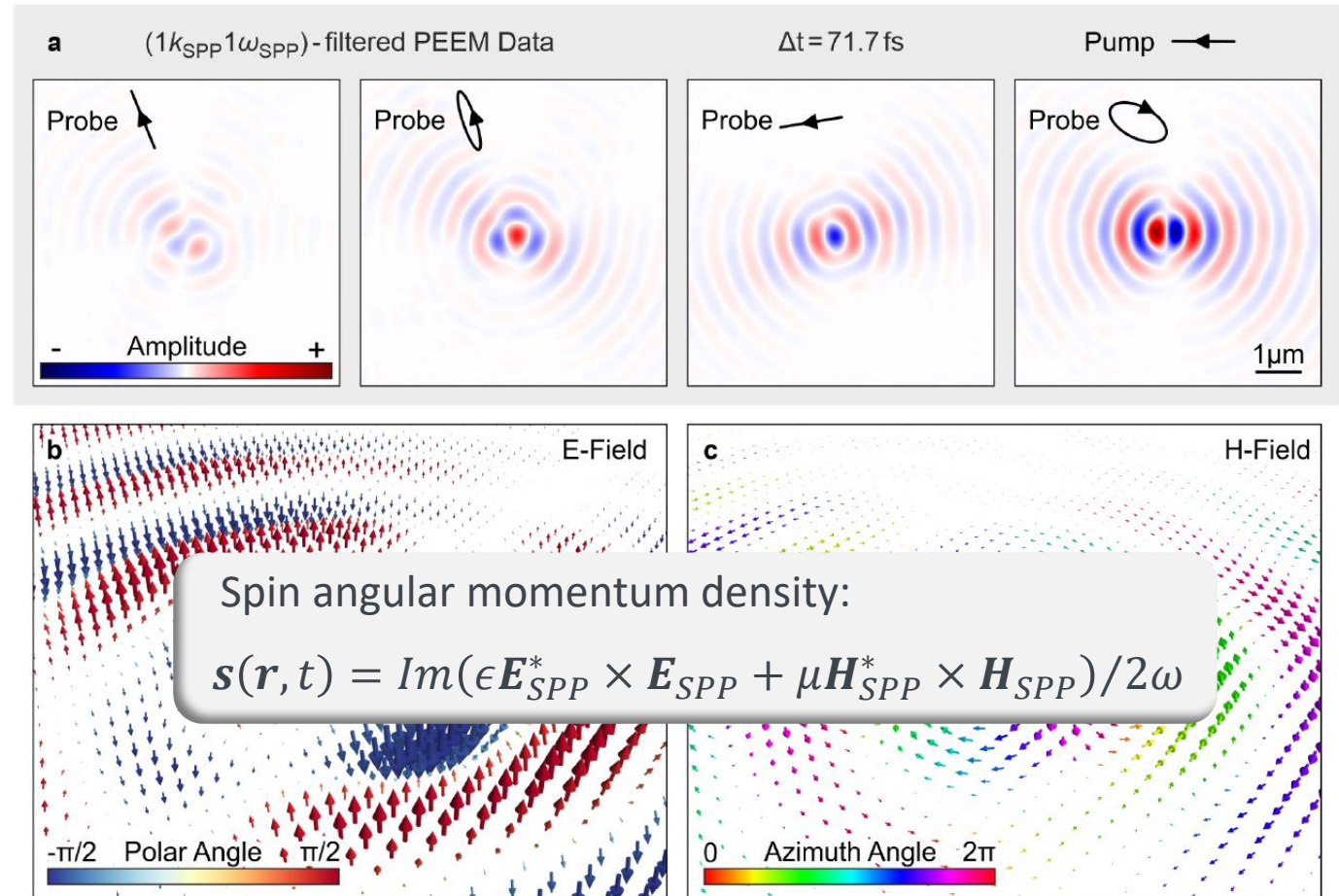
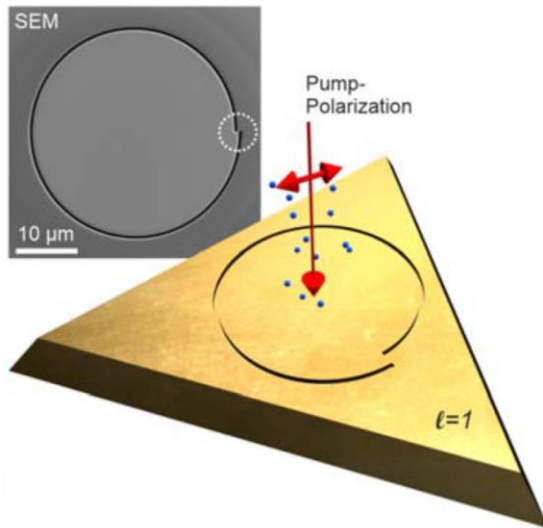


T. J. Davis et al., Science **368**, eaba6415 (2020)

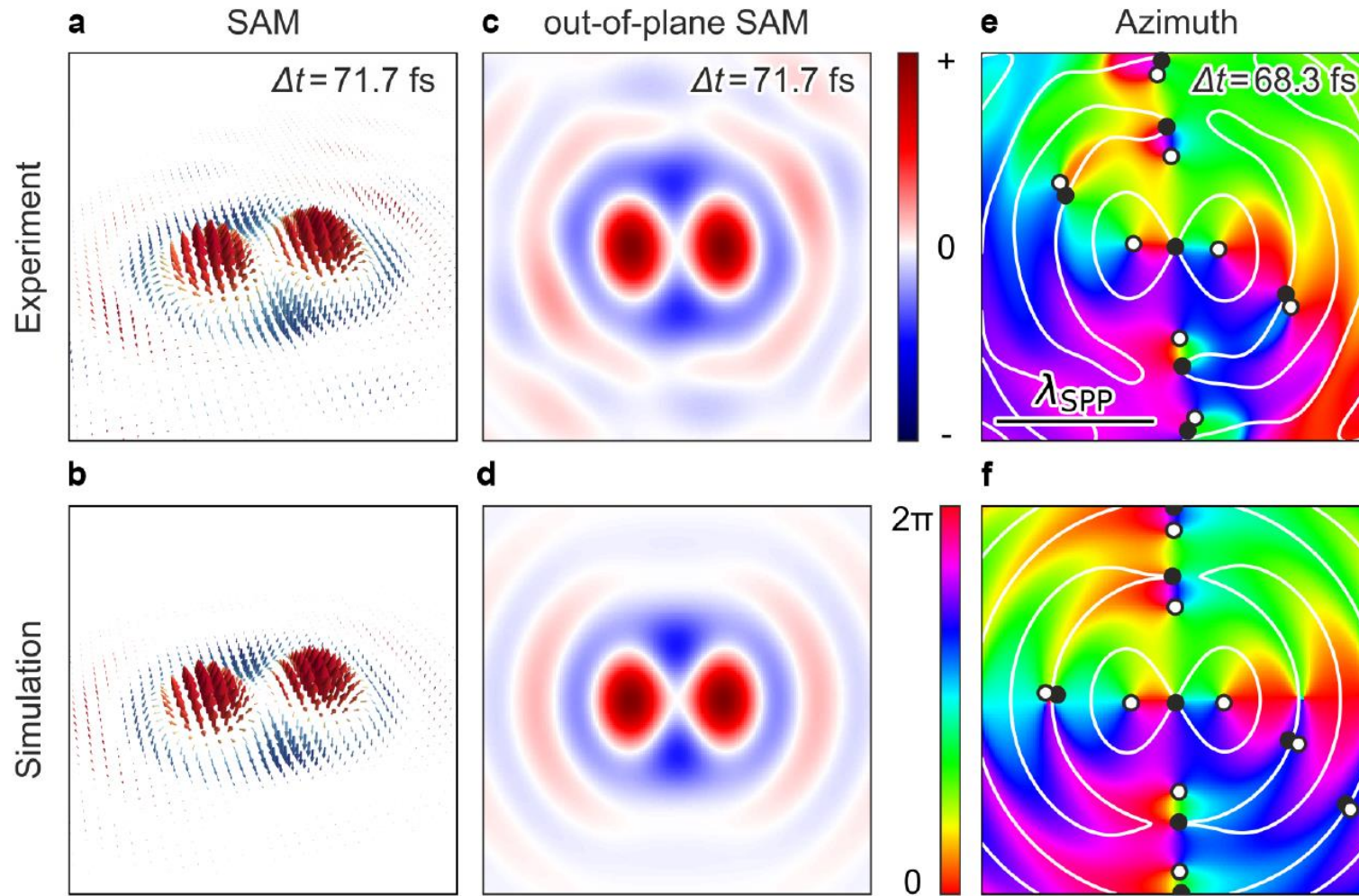




Meron pair excitation structure



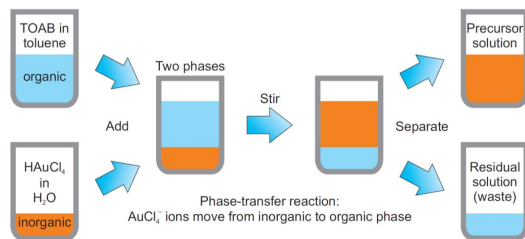
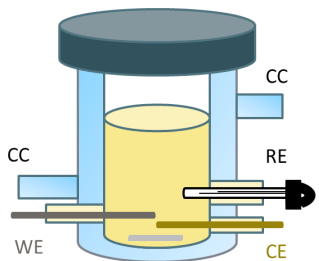
P. Dreher et al., submitted (2024)



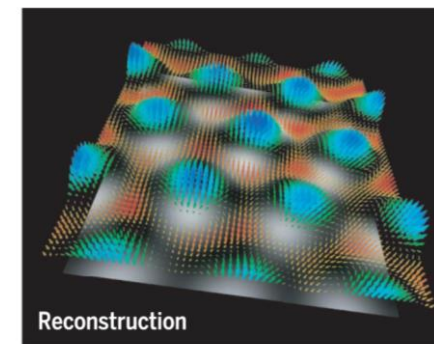
P. Dreher et al., submitted (2024)



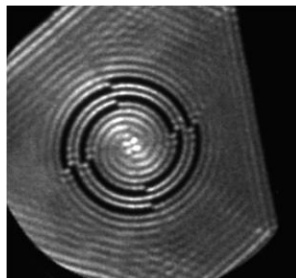
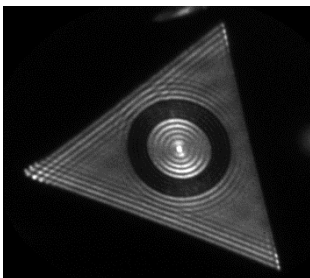
Single crystalline gold platelets



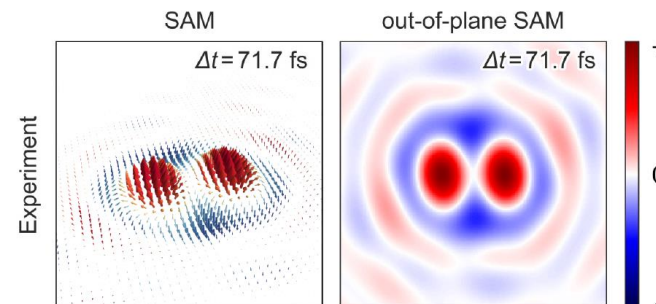
Plasmonic skyrmions



Surface plasmonics



Plasmonic spin meron pairs



Bundesministerium für Bildung und Forschung

